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Prevalence and Distribution of Rice Sheath Rot (*Sarocladium oryzae*) in Jammu Division

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Abstract
Rice sheath rot caused by Sarocladium oryzae is an emerging fungal disease, spreading over rice-growing areas in Union Territory of Jammu and Kashmir. Extensive roving surveys were undertaken during *Kharif* seasons of 2019 and 2020 to determine the status and distribution of the disease in major rice-growing districts Jammu division in *viz*., Jammu, Samba, Kathua, Rajouri and Udhampur as location-specific surveillance. The disease was widespread in all the locations in varying proportions during both the years. The percent disease index (PDI) varied from 15.83-38.71 and 15.67-37.00 per cent with overall mean of 27.93 and 26.48 per cent during the *Kharif* seasons 2019 and 2020, respectively. However, pooled data of both the years revealed that the mean PDI ranged between 15.75-37.86 per cent. The highest overall mean PDI of 34.53 per cent was recorded in district Jammu followed by 31.59, 28.58, and 23.17 per cent in Udhampur, Rajouri and Kathua districts, respectively and it was minimum i.e. 18.15 per cent in the district of Samba. The mean PDI was higher during *Kharif* 2019 (27.93%) than in *Kharif* 2020 (26.48%).

Keywords: *Sarocladium oryzae*, sheath rot, PDI, survey, rice

1. Introduction
Rice (*Oryza sativa* L., Family: Poaceae) is the world's single most important cereal crop and staple food for more than half of the global population (Ramya *et al*., 2018; Prasad *et al*., 2020) [12, 11]. It is grown in 0.28 million ha, in Jammu Division of Jammu and Kashmir Union Territory (UT), with production of 0.58 million tonnes and productivity of 2.09 tonnes/ha (Anonymous, 2020) [2]. The crop is inflicted by several diseases which causes enormous quantitative and qualitative losses. Among various diseases several minor diseases have become serious problems in the state. Sheath rot is one such example which has emerged as of a major threat in the state during the panicle initiation or booting stage. It is inflicted by *Sarocladium oryzae*, and yield losses have been reported to be 20-85 per cent (Peeters *et al*., 2021) [9]. In India, it was reported for the first time by Agnihothrudu (1973) [1]. It affects all the rice cultivars in both rainfed and irrigated habitats. *S. oryzae* infection initiates as greyish-brown necrotic lesions on the flag leaf sheath, which enlarges until the entire leaf sheath is necrotic (Peeters *et al*., 2020) [10]. Enclosed panicles are affected, resulting in sterile, empty or discoloured grains, under severe infection with only partial or incomplete emergence of the panicle (Mvuyekure *et al*., 2018; Bigirimana *et al*., 2015) [7, 3]. In UT of Jammu & Kashmir, the disease is regularly occurring in moderate form in many rice-growing areas. However, little information is available on the prevalence (status) and distribution of the disease. Hence, the present investigation was undertaken to study its status and distribution in Jammu division during *Kharif* 2019 and 2020 following a survey of major rice cultivated areas of Jammu division.

Material and Methods
Assessment of sheath rot status
Systematic surveys were conducted during cropping seasons of *Kharif* 2019 and 2020 for assessing the status and distribution of sheath rot in five districts of Jammu division *viz*., Jammu, Samba, Kathua, Rajouri and Udhampur. From each district, three blocks, from each block two villages and from each village five fields were selected to record the data on disease severity.

Data recording

The data were recorded at each field by randomly throwing 1 x 1m quadrant at five sites to record observations for disease before the maturation of the crop. Ten plants were chosen at each place where the disc landed. Disease severity was recorded using 0-9 proposed by (Anonymous, 1996) [5] (Table 1). Per cent disease index (PDI) was calculated by using the following formula given by Wheeler, 1969 [16].

$$\text{Per cent disease index (PDI)} = \frac{\text{Sum of all numerical values}}{\text{Total no. of tillers observed x Maximum grade}} \text{x } 100$$

Results

Symptomatology of sheath rot of rice

Symptoms were more severe during the panicle initiation/booting stage on the flag leaf sheaths enclosing the emerging young panicles.

Table 1: Scale used to record disease severity of sheath rot of rice.

Disease Score.	Scale description
0.	No lesion or spot on flag leaf sheath.
1.	Spots visible on the tillers upon very careful examination (less than 1% flag leaf sheath area covered).
3.	Spots visible on the tillers upon careful examination (1-5% flag leaf sheath area covered).
5.	Spots easily visible on the tillers (6-25% flag leaf sheath area covered).
7.	Spots present on almost whole the tillers parts (26-50% flag leaf sheath area covered).
9.	Spots very common on whole the tillers parts (51-100% flag leaf sheath area covered) death of plants common, severe yield loss.

On the sheath enveloping the young panicle, there was appearance of oval to irregular dark brown lesions with a greyish center. Lesions were oblong or irregular oval patches with an undulated dark margin and grey or light brown centers or reddish-brown centers. Later, the spots enlarged, coalesced and eventually covered the majority of the leaf sheath. Inside the flag leaf sheath, the infection spread across the entire sheath area, covering the immature panicle or growing plant part (Fig. 1). The white fungal growth was visible as a whitish powdery mass between the flag leaf sheath and the young growing panicle when the infected flag leaf sheath was opened. The grains of infected panicle were discoloured, reddish-brown, and may not be filled.

To determine the status and distribution of sheath rot disease. Roving surveys undertaken in major rice-growing districts *viz*., Jammu, Samba, Kathua, Rajouri and Udhampur of Jammu division, during *Kharif* seasons of 2019 and 2020, revealed that the disease was widespread on rice crops at all the locations during both the years. The data (Table 2) on the status of sheath rot revealed it was observed that the per cent disease index (PDI) in Jammu division varied from 15.83-38.71 per cent with an overall mean of 27.93 per cent during *Kharif* 2019 and, during *Kharif* 2020 similar trend was observed, although the average disease index was slightly lesser as is evident from the fact that PDI varied from 15.67-37.00 per cent with an overall mean of 26.48 per cent during 2020. The highest PDI during 2019 and 2020 (38.71 and 37.00%) was recorded in village Rangpur Maulania in R. S. Pura block followed by village Allah (37.35 and 35.11%) of Bishnah block (Jammu), Chak Galwade (35.56 and 34.22%) of Marh block (Jammu) and Ladan (35.17 and 34.56%) of Udhampur block (Udhampur). It was the least in Channi (15.83 and 15.67) followed by Bari Kamail (15.94 and 16.78%) of Vijaypur block (Samba), Surara (18.44 and 16.89%) and Ratwana (18.68 and 17.75%) of Ghagwal block (Samba) respectively, during 2019 and 2020.

Among the various districts surveyed the highest overall mean PDI i.e. 35.48 and 33.57 per cent was recorded in district Jammu followed by Udhampur (32.34 and 30.83%), Rajouri (29.35 and 27.81%), Kathua (23.91 and 22.42%) and it was minimum with overall mean PDI of 18.54 and 17.75 per cent was recorded in district Samba during *Kharif* 2019 and 2020, respectively (Fig. 2). Pooled data of both the cropping season (*Kharif* 2019 and 2020) revealed that the overall PDI in Jammu division ranged from 15.75-37.86 per cent with an overall mean PDI of 27.20 per cent. The highest PDI was recorded in village Rangpur Maulania (37.86%) of R. S. Pura block (Jammu) followed by Allah (36.23%) in Bishnah block, Chak Galwade (34.89%) of Marh block in district Jammu, Ladan (34.86%) of Udhampur block (Udhampur). The overall mean PDI was highest in district Jammu (34.53%) followed by Udhampur (31.59%), Rajouri (28.58%) and Kathua (23.17%) and it was minimum in district Samba (18.15%) (Fig. 2; Table 2).

Fig 1: Sheath rot symptoms on rice plant A) infected flag leaf sheath; B) incomplete emergence of grains

Pooled data of both the cropping season (*Kharif* 2019 and 2020) revealed that the overall PDI in Jammu division ranged from 15.75-37.86 per cent with an overall mean PDI of 27.20 per cent. The highest PDI was recorded in village Rangpur Maulania (37.86%) of R. S. Pura block (Jammu) followed by Allah (36.23%) in Bishnah block, Chak Galwade (34.89%) of Marh block in district Jammu, Ladan (34.86%) of Udhampur block (Udhampur). The overall mean PDI was highest in district Jammu (34.53%) followed by Udhampur (31.59%), Rajouri (28.58%) and Kathua (23.17%) and it was minimum in district Samba (18.15%) (Fig. 2; Table 2).

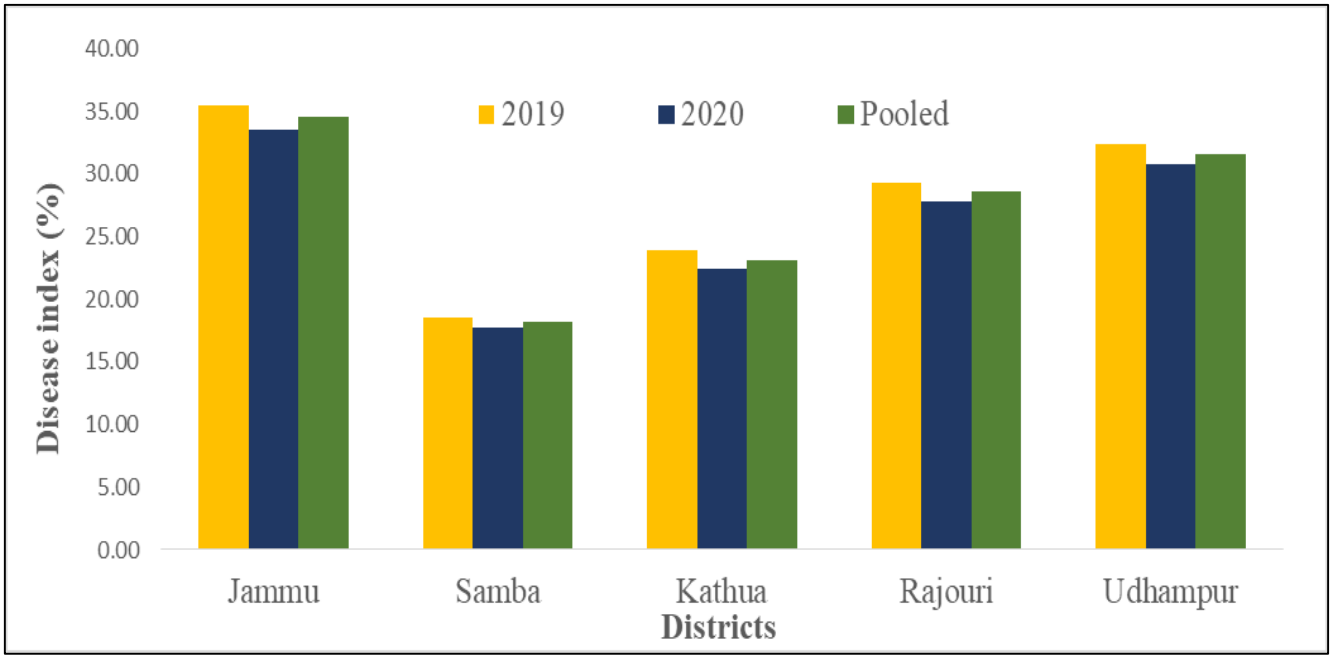

Fig 2: Percent disease index of rice sheath rot in different districts of Jammu division during *Kharif* 2019 and 2020

Table 2: Status of sheath rot of rice in Jammu region during the cropping season *Kharif* 2019 and 2020

District	Location	Village	AMSL (m)	Disease index (%)		
				2019	2020	Pooled
Jammu	Bishnah	Allah	269.0	37.35	35.11	36.23
		Deoli	267.0	33.67	32.44	33.06
	Marh	Marh	554.0	34.72	32.00	33.36
		Chak Galwade	261.0	35.56	34.22	34.89
	R. S. Pura	Rangpur Maulania	267.0	38.71	37.00	37.86
		Kirpind	270.0	32.89	30.67	31.78

		Mean ± S.E.(m)		35.48±0.90	33.57±0.94	34.53±0.92
		Range		32.89-38.71	30.67-37.00	31.78-37.86
Samba	Vijaypur	Channi	336.0	15.83	15.67	15.75
		Bari Kamail	360.0	15.94	16.78	16.36
	Samba	Badheri	334.0	19.73	18.56	19.14
		Daboh	340.0	22.61	20.89	21.75
	Ghagwal	Ratwana	422.0	18.68	17.75	18.02
		Surara	394.0	18.44	16.89	17.67
		Mean ± S.E.(m)		18.54±1.03	17.75±0.74	18.15±0.89
		Range		15.83-22.61	15.67-20.89	15.75-21.75
Kathua	Hiranagar	Chanori	440.0	25.28	23.11	24.19
		Jatwal	412.0	19.17	18.22	18.69
	Bilawar	Machhedi	1694.0	26.39	24.67	25.53
		Dewal	654.0	25.50	24.00	24.75
	Kathua	Uttri	399.0	24.70	24.11	24.41
		Sahaar	449.0	22.44	20.41	21.43
		Mean ± S.E.(m)		23.91±1.10	22.42±1.04	23.17±1.07
		Range		19.17-26.39	18.22-24.67	18.69-25.53
Rajouri	Rajouri	Fateh Pur	1026.0	31.39	29.78	30.58
		Talwal	1027.0	28.22	28.11	28.17
	Thanamandi	Behrote	1284.0	30.28	27.22	28.75
		Nerojal	1177.0	26.44	24.56	25.50
	Darhal	Darhal	1543.0	27.11	25.89	26.50
		Sagrawat	1565.0	32.67	31.33	32.00
		Mean ± S.E.(m)		29.35±1.01	27.81±1.04	28.58±1.03
		Range		26.44-32.67	24.56-31.33	25.50-32.00
Udhampur	Udhampur	Ladan	745.0	35.17	34.56	34.86
		Jakheni	795.0	28.00	26.78	27.39
	Tikri	Sundrani	922.0	33.28	30.56	31.92
		Cherai	788.0	30.17	28.56	29.36
	Manwal	Thalora	606.0	34.56	33.11	33.83
		Chiani	538.0	32.89	31.44	32.17
		Mean ± S.E.(m)		32.34±1.12	30.83±1.17	31.59±1.15
		Range		28.00-35.17	26.78-34.56	27.39-34.86
Jammu Division		Overall Range		15.83-38.71	15.67-37.00	15.75-37.86
		Overall Mean		27.93	26.48	27.20

Discussion

Rice sheath rot caused by *S. oryzae* is a major fungal pathogen of rice (Bigirimana *et al*., 2015) [3]. Sheath rot affects all growth stages but the most severe infections have been reported at booting/grain filling stage (Pearce *et al*., 2001) [8]. This disease was used to be considered as a geographically limited however, it has become widespread in major rice cultivated areas in recent years (Zhang *et al*., 2020) [17]. In the present study, it was revealed that sheath rot was prevalent in all the locations surveyed during *Kharif* 2019 and 2020. The PDI in Jammu division varied from 15.83-38.71 and 15.67-37.00 per cent with overall mean of 27.93 and 26.48 per cent during *Kharif* 2019 and 2020, respectively. However, pooled data of both the years revealed that the mean PDI ranged between 15.75-37.86 per cent with overall mean PDI of 34.53 per cent was the highest in district Jammu followed by 31.59, 28.58, and 23.17 per cent in Udhampur, Rajouri and Kathua, respectively and it was minimum i.e. 18.15 per cent in the district of Samba The mean PDI was higher during *Kharif* 2019 (27.93%) than in *Kharif* 2020 (26.48%). As has been observed in the present studies, various workers conducted surveys to determine the severity of rice sheath rot in various areas (Srinivasan, 1981; Singh, 1988) [14, 13]. Girish (1999) [4] conducted a survey in many districts of Karnataka and observed that sheath rot ranged from 26.40-44.50 percent in district Bangalore and the district, highest prevalence of 47.30 per cent was recorded in Tumkur. Similarly, Jakkuva (2012) [6] recorded the per cent disease index of sheath rot 6.67-37.78 per cent in Karnatka, Arabhavi (Belgaum) had the highest PDI (37.78%), while Veeravalli had the lowest (West Godavari) PDI. The mean PDI of 15.75-37.86 per cent recorded in Jammu division corroborated by the earlier studies. Variations in disease index in different locations might be attributable to varying environmental conditions (temperature and relative humidity) for disease development, continuous rice cultivation on large area, monoculture, use of nitrogenous fertilizers, pathogen population variation, and lack of awareness among farmers resulting in non-adoption of disease management strategies. Furthermore, variations in PDI in different districts could be attributed to the use of different rice varieties. Pathogens are adapting to changing climates and are becoming more severe on different crops (Velasquez *et al.*, 2018) [15]. Continuous prevalence of pathogen and its changing status from previously unimportant to a serious problem in the UT of J & K necessitates that a sound scientific basis management strategy needs to be adopted to manage the disease.

Conclusion

Sheath rot of rice is a matter of concern, as it is known to cause infection on boot leaf sheath and result in discolouration of grains. The overall mean PDI in district Jammu was maximum followed by Udhampur, Rajouri and Kathua and it was minimum in the district of Samba. The timely suggestions based on sheath rot prevalence is very

important for farmers to take prophylactic measures against the disease. The increasing disease severity of sheath rot in Jammu division eventually warrant farm scientists to assist farmers and policymakers by predicting disease epidemics and implementing effective and timely management strategies.

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